EMBA Concentration Class

Electricity Market Game: some notes

M.G. Pollitt

Cambridge Judge Business School

1. **Session 1 (May 29, 2018) – Energy only bidding**

Each electricity-producing firm has its own marginal cost curve which is determined by the structure and characteristics of its portfolio of electricity generating plants.[[1]](#footnote-1) Based on that marginal cost curve, firms place bids in the wholesale electricity market, offering a set capacity at a given price (in £/MWh). Taken together, those bids form the firm’s bid curve which, in essence, is nothing else than the firm’s supply curve.

The equilibrium in the wholesale electricity market is determined by the interaction between the *industry* (aggregate) supply curve and the market demand curve. In the present context, the demand curve is assumed to be fully (price)-inelastic.

1. **A word on the CO2 game**

The introduction of a price on CO2 emissions should alter firms’ behaviour. The decision-making process now involves accounting for both the marginal cost of each plant and the (marginal) cost of CO2. Bidding in the CO2 market by firms will affect the ratio of bid to allowance allocation ratio and, hence, the amount of emissions that will be paid for at the equilibrium price of the CO2 market versus emissions for which the “fine” (£16) will be paid. This, in turn, will affect each firm’s profit.

1. **Investment game**

This exercise focuses on the investment decision of electricity generating firms. It is intended to illustrate the effect of firms’ investment decision on a stylised wholesale electricity market. Unlike the “energy-only” or “energy + co2” games, the “investment game” consists in 30 periods. The objective of each firm present in the market is to maximize its Net Present Value (NPV) over the entire investment horizon.

The sheets corresponding to this exercise in each company’s (excel) file are “investment option” and “investment choice”. The former contains information about the different investment options available to each firm.[[2]](#footnote-2)

It is assumed that CO2 emissions are taxed in all rounds according to a specific tax schedule. Therefore, as part of your decision-making process, you should consult the sheet “co2 emission” which contains information about the time evolution of the co2 tax rate.

Based on that information, each firm is required to make an investment decision which consists of the following information:

1. Type of investment
2. Desired capacity to install
3. Lead-in round[[3]](#footnote-3)

Note:

* The algorithm will disregard an investment if the lead-in time specified is below the threshold lead-in round indicated in column I ‘Lead-in after round’ of tab ‘investment option’.
* The maximum new capacity that can be invested in/installed in each round is an absolute maximum, i.e. one cannot specify three different investments of, say, 800 MW of Wind in the same round to try and install 2400 MW at once. Again, the algorithm will disregard such decisions and assume that 800 MW have been installed.

Investment decisions should then be recorded in the “investment choice” sheet. The number of separate investments should not exceed 20 (cf. sheet). If a plant’s lifetime extends beyond the last round, its terminal value in the last round will be positive.

The investment decisions should be sent back via e-mail at the following address: gd396@cam.ac.uk by June 4.

1. Remember that in the present stylised market setup, the marginal cost of each plant is equal to its fuel cost. [↑](#footnote-ref-1)
2. The information provided is the following: plant lifetime (years), capital cost (£/MW), operational costs (£/year/MW), efficiency, capacity (MW) – max and min, earliest lead-in round [↑](#footnote-ref-2)
3. The "lead-in after round" is meant to mimic the real life construction time lags: construction of a nuclear power plant takes much longer than that of a wind farm. The wind farms can be invested in at or after round 3, similar for nuclear power plants (at or after round 6), etc. The lead-in round on the tab "investment choice" refers the lead-in time. At round [t] the plant comes into operation. Yet, the investment time is [t-1] and hence the total capital cost is incurred in [t-1]. This means the profit, most likely, would drop in the round [t-1] and then the profit should increase in the next rounds as the players earn profit on their investment. [↑](#footnote-ref-3)